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MATHEMATICS.—*Note on rotations in hyperspace.* EDWIN BIDWELL WILSON, Massachusetts Institute of Technology.

In a recent paper C. L. E. Moore[1] has discussed rotations in hyperspace, by treating first the resolution of a complex 2-vector M into mutually completely perpendicular simple 2-vectors or planes. The problem is of sufficient interest, perhaps, to justify my sketching very briefly the method by which I attacked the problem of discussing rotations in hyperspace in a paper read before the American Mathematical Society[2] over ten years ago, but never published. My method was founded on the general reduction of the homogeneous strain to canonical form, and in particular on the work subsequently printed in this JOURNAL.[3] It is there shown that a real strain about a fixed point has four types of transformation as possibilities.

1. The tonic. That is a stretching along a fixed direction. This corresponds to a real root of the characteristic equation, and to each real root there is at least one such direction in space.[4]

2. The shear. This arises only when two or more real roots of the characteristic equation are equal, and consists in the

[1] MOORE, C. L. E. *Rotations in hyperspace.* Proc. Amer. Acad. 53: 651–694. 1918.

[2] See, Bull. Amer. Math. Soc. 13: 265. 1907.

[3] WILSON, EDWIN B. *Note on multiple algebra; the reduction of real dyadics and the classification of real homogeneous strains.* Journ. Wash. Acad. Sci. 7: 173–177. 1917.

[4] The multiplier may be negative, *i. e.*, the stretching may be accompanied by a reversal of direction; nevertheless for analytical reasons, we may speak of a fixed "direction."

simplest case of the superposition upon the stretching of a sliding parallel to the fixed direction, and proportional to the distance from the fixed direction, as is necessary if lines originally passing through the origin are to remain lines passing through the origin. The shear may be of various degrees of complexity; for example, if there are three equal real roots there is a plane through the fixed direction which is fixed, and in it the shear is simple; whereas the displacement of points not in this fixed plane is partly in the fixed direction and partly in another direction parallel to the fixed plane. (It is not necessary that there be shearing when there are multiple roots. It is clear that two different directions in space may be fixed with the equal ratios of stretching for those directions, and with the same ratio for all directions in their plane.)

3. Cyclotonic. This is a combination of stretching with elliptic rotation in a plane. It arises when there is a pair of conjugate imaginary roots in the characteristic equation. All lines are stretched in a definite ratio, and are turned through a definite "angle," provided angle be measured by the sectorial area in an ellipse concentric with the fixed point instead of by the sectorial area in a circle.

4. The cyclotonic-shear. In the simplest case, where the characteristic equation has a pair of conjugate imaginary roots, each occurring twice, the transformation consists in a cyclotonic change in each of two nonintersecting planes through the origin combined with a displacement parallel to one of the pairs. For conjugate imaginary roots of greater multiplicity various complexities of cyclotonic-shear are possible. (It is not necessary, however, that shear accompany multiple roots in this case any more than in case the roots are real.)

A rotation is a transformation in which length and an angle remain unchanged. As length remains unchanged it follows that all the real roots of the characteristic equation must be either $+1$ or -1; for otherwise there would be at least one direction in which stretching took place. Moreover, the magnitudes of the imaginary roots must also be equal to $+1$, *i. e.*, the roots must be complex quantities or there would be at least one plane

in which stretching took place. Next, if a real root is double, there can be no shear corresponding to that double root, because in the shear all lines through the origin in a fixed plane through the fixed direction must change their direction, with the sole exception of the fixed direction itself, and an angle cannot remain always unchanged in the case of a shear. In like manner, it may be seen that when an imaginary root is multiple, the shearing terms must be absent if the strain reduces to a rotation.

If there are a certain number of real roots equal to $+1$, a space of the same number of dimensions is left absolutely unchanged. If there are a certain number of roots -1, these may be paired to represent a rotation of 180° in a certain number of planes, which will take care of all if the number of roots -1 is even. If the number is odd, there will be one direction left over, along which directions are reversed. This case corresponds not to a rotation, but to a reflection, and, consequently, the number of roots -1 must be even. The transformation of rotation, therefore, reduces to the identical transformation in a space of a certain number of dimensions, and to rotations through angles of 180° or otherwise in a number of independent planes sufficient to make up the total multiplicity of the hyperspace.

The fact that there are no shearing terms in the dyadic or in the matrix, Φ, means algebraically that the equation of lowest degree satisfied by the dyadic has only as many factors as there are different roots in the characteristic equation, each factor raised to the first power, namely:

$$(\Phi - \mathrm{I})(\Phi + \mathrm{I})(\Phi - e^{i\theta}\mathrm{I})(\Phi - e^{-i\theta}\mathrm{I}) \ldots\ldots = 0$$

or

$$(\Phi^2 - \mathrm{I})(\Phi^2 - 2\cos\theta\Phi + \mathrm{I}) \ldots\ldots = 0$$

It is necessary to point out that the different independent spaces which correspond to the different roots of the equation are perpendicular. Consider, for instance, any direction in a space corresponding to $+1$, and any direction in that corresponding to -1. The transformation leaves the first direction unchanged, and reverses the second, so that each angle is changed into its supplement; and if angles are to remain unchanged, the directions must be perpendicular. In like manner, there may

be considered a direction in the space corresponding to $+1$, and a direction in one of the planes in which rotation occurs. If the plane is not perpendicular to the direction, there is one line in the plane which is, and only one. The rotation will turn this line into another direction in that plane, and, consequently, will change a right angle into some other angle; hence, the plane must be perpendicular to the direction.

In a similar way, consider two planes in which there is rotation. Unless the planes are perpendicular, there is just one line in one of the planes which is perpendicular to the other plane. The operation of the rotation in the two planes will throw this line into some other, and again angles will be changed, which is impossible in a rotation; and the planes must, therefore, be perpendicular. It therefore follows that the fixed space and space in which directions are reversed and the various planes in which there are rotations are all mutually perpendicular in the sense of complete perpendicularity.[5]

This brings the discussion to an end by the determination of the fundamental existence-theorem for rotations in generalized space. It is the theorem which Moore establishes prior to subsequent work. The method of treating rotations in ordinary space which was given by Gibbs in his lectures, and may be found in the *Vector Analysis*,[6] is dependent upon the knowledge that in three dimensions a rotation has a fixed axis. Much of the subsequent work, however, could, I believe, be carried over to higher dimensions in much the same way as the simpler case was treated by Gibbs.

CHEMISTRY.—*Note on the Bucher cyanide process for the fixation of nitrogen.* EUGEN POSNJAK and H. E. MERWIN, Geophysical Laboratory, Carnegie Institution of Washington.

In the course of an investigation of the Bucher cyanide process[1] undertaken by this Laboratory at the request of the

[5] The treatment may, of course, be carried through analytically by taking a general vector ρ and its transform $\phi\rho$ calculated from the canonical form, and by expressing the conditions on the coefficients of δ which require constancy of length and invariance of angle.

[6] WILSON, EDWIN B. Vector Analysis (Gibbs). New York, Charles Scribner's Sons, 1901. See pp. 334–347.

[1] Journ. Ind. Eng. Chem. 9: 233. 1917.

Nitrate Division of the Ordnance Department of the Army, it was found by means of microscopical examinations that the nitrogen-bearing constituent of some of the crude technical products manufactured by this process consisted principally of some other substance than ordinary sodium cyanide.

Ordinary sodium cyanide was found to be an essentially isotropic substance, crystallizing in cubes, and having a refractive index of 1.452 ± 0.003. After this cyanide had been fused, slight double refraction amounting to about 0.005 was observed.

The material found in the technical products above mentioned appeared in weakly doubly refracting colorless grains about 0.03 mm. in diameter. The refractive indices are $\alpha = 1.527$, $\beta = 1.532$, $\gamma = 1.537$. The optic axial angle observed was so near 90° that the optical character could not be determined.

Evidently only chemical tests were made by Bucher. It was therefore necessary to repeat his experiments to establish whether sodium cyanide or this other substance was formed by his reaction. The Bucher process, as known, consists in heating a mixture of sodium carbonate, charcoal, and iron powder (catalyst) in a stream of nitrogen at a temperature above 900°. The reaction is written as follows:

$$Na_2CO_3 + 4C + N_2 \rightleftarrows 2NaCN + 3CO$$

In our experiments, mixtures containing varying amounts of sodium carbonate, carbon, and iron were prepared. Each was placed in an iron boat within an electric furnace which contained a reaction chamber consisting of a copper tube closely fitting within one of silica glass. A stream of nitrogen was passed through the tube while a certain temperature between 900° and 1000° was maintained for several hours. The reaction product was rapidly cooled by lifting the tube out of the furnace without interrupting the flow of nitrogen and was then examined microscopically. In all experiments sodium cyanide, together with some of the ingredients of the original mixture, proved to be present, which confirms the reaction given by Bucher.

As it did not seem feasible to investigate the conditions of formation of the substance in question at the factory, attempts

were made to recover it in sufficient purity from the crude product with the view of preparing a sample for analysis.

Recovery by distillation was first tried in the following way: The crude product was put in a copper tube which was closed at one end and which fitted inside a similar tube of silica glass. These tubes were placed in an electric furnace and heated about three hours at 800° while the other end of the tube was connected with a vacuum pump and cooled. When taken apart no change could be observed.

The same experiment was repeated at approximately 975°. It was now necessary to run the pump constantly as an evolution of gas was taking place. On taking the apparatus apart metallic sodium was found in the cold portion of the tube. Inasmuch as the crude product usually contains sodium carbonate, the following reaction probably took place:

$$Na_2CO_3 + 2C = 2Na + 3CO$$

Microscopical examination of the crude product in the tube showed that the substance in question still remained. Thus distillation appears not to be a suitable method for its separation.

According to Bucher,[2] sodium cyanide can be easily distilled out of his briquets at a temperature even below 800°. These experiments therefore substantiate the microscopical evidence that the samples of the crude product examined do not contain any appreciable amount of sodium cyanide.

The investigation of the chemical nature of the substance in question is being continued.

PHYSICAL CHEMISTRY.—*Some physical constants of mustard "gas."* LEASON H. ADAMS and ERSKINE D. WILLIAMSON, Geophysical Laboratory, Carnegie Institution of Washington.

Some time ago it was desired, for military purposes, to know the compressibility of so-called mustard gas. Accordingly, the necessary measurements were carried out at this laboratory,

[2] Loc. cit., p. 246.

and at the same time certain other properties of this substance were determined from its behavior under hydrostatic pressure.

The compound 2,2-dichloroethylsulfide[1]—$(C_2H_4Cl)_2S$—is known as mustard gas or mustard oil, and is, when pure, a colorless, oily liquid which boils about 217°. The compressibility was measured by the same method and using the same apparatus as that already described.[2] The procedure, in brief, is as follows: The material to be compressed is surrounded by kerosene in the interior of a thick-walled steel cylinder, one end of which is closed while the other end is fitted with a piston and leak-proof packing. By means of a hydraulic press the piston is forced into the cylinder, thus subjecting the kerosene and the given material to hydrostatic pressure and thereby decreasing the volume of each. The decrease in volume of the substance for each increment of pressure is determined from a pair of readings of pressure and corresponding piston displacement. Pressures were measured by an electrical method, the precision being such that one scale division was equal to about one megabar;[3] the displacement of the piston was read on a dial micrometer which was graduated to 0.01 mm. Temperature regulation was obtained by an electric heating coil of asbestos-covered "nichrome" wire wrapped around the heavy steel cylinder and covered with an insulating layer of felt. About 10 g. of the material was contained in a steel capsule closed at the top and terminating below in a capillary which dipped into a cup containing mercury. Pressure could thus be transmitted through the mercury seal to the interior of the capsule.

Table 1 shows the results for the decrease in volume (at 31.5°) of the liquid under pressure. The second and third columns of the table give for two separate runs the values of $-\Delta v/v_0$ where Δv is reckoned from the initial pressure, $P_0 = 392$ megabars, and v_0 is the volume[4] of the liquid at 31.5° and atmos-

[1] Also called thiodiglycolchloride. Conf. BEILSTEIN, Vol. I, p. 358. Ber. Deutsch. Chem. Ges. 19: 3260. 1886.

[2] Journ. Amer. Chem. Soc. 41: January, 1919.

[3] 1 megabar = 10^9 dynes/cm^2. = 1.020 kg./cm^2. = 0.987 atm.

[4] This was calculated from the known density which at 20°, 25°, 30°, and 35°, respectively, is 1.274, 1.269, 1.264, and 1.258.

pheric pressure. The values of Δv as a function of P may be represented by a power series yielding the equation

$$\Delta v/v_0 = 4.24 \times 10^{-5} (P - P_0) - 6.3 \times 10^{-5} (P - P_0)^2$$

however, the results are expressed equally well by the exponential equation

$$-\Delta v/v_0 = 0.118[1 - e^{-0.364 \cdot 10^{-3} (P - P_0)}] \qquad (1)$$

which gives a more reasonable course to the compressibility curve and hence is to be preferred for extrapolating to zero pressure. In the third column of table 1 are shown the values of $-\Delta v/v_0$ calculated from equation (1).

By differentiation this equation becomes

$$-dv/dP = 49.5\, e^{-0.364 \cdot 10^{-3} P} \qquad (2)$$

from which we find the compressibility $(-dv/dP)$ at $P = 0$ to be 49.5×10^{-6} per megabar, while at 1000 and 2000 megabars, respectively, the compressibility is 34.4×10^{-6} and 23.9×10^{-6}.

TABLE 1

DECREASE IN VOLUME OF MUSTARD "GAS" UNDER PRESSURE

PRESSURE MEGABARS	$-\Delta v/v_0$ (OBS.)		$-\Delta v/v_0$ (CALC.)
	(1)	(2)	
392	0.0000	0.0000	0.0000
840	0.0175	0.0179	0.0177
1280	0.0327	0.0331	0.0326
1713	0.0447	0.0450	0.0450

After the conclusion of the measurements of compressibility the freezing pressure and resultant change of volume at a few temperatures were determined. This could be done without removing the material from the apparatus. By referring to figure 1 it may be seen how the desired quantities may be obtained from a series of readings, at constant temperature, of pressure P, and piston-displacement R. When freezing or melting of the substance in the capsule takes place, P remains constant while R increases or decreases and the resulting discontinuity at once locates the freezing pressure for the given temperature.[5] Moreover, the change in volume on melting may be

[5] Conf. BRIDGMAN, Proc. Amer. Acad. 47: 415. 1911.

obtained by multiplying the cross-section of the piston by the quantity $R_2 - R_1$ which is obtained graphically (see Fig. 1).

The necessary readings must be taken with decreasing pressure since, on account of the propensity of liquids for under-cooling to a temperature several degrees below their melting point, they will generally support a pressure far beyond the true freezing pressure before solidification takes place.[6] Dichloroethylsulfide requires at ordinary temperatures about 1000 megabars superpressure to start it freezing. This corresponds to an undercooling of 14°.

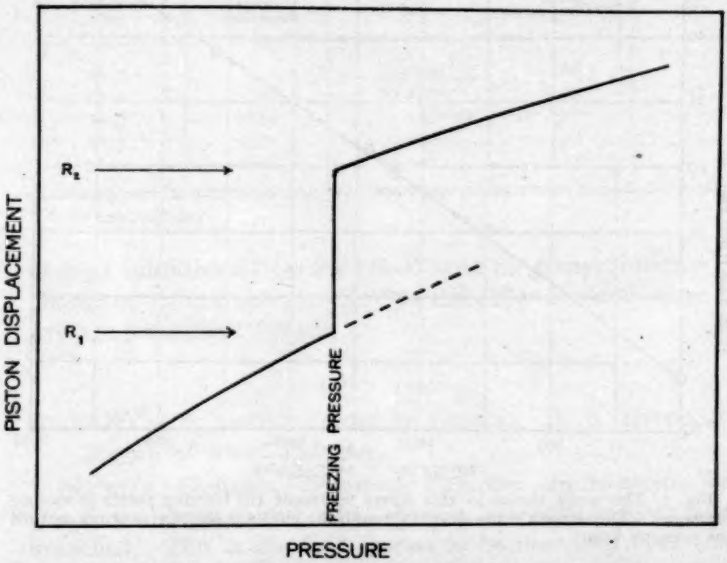

Fig. 1. Diagram to illustrate how the freezing pressure and consequent change of volume may be obtained by plotting pressure against piston-displacement. When the pressure on the liquid is raised, freezing does not take place promptly and the liquid thus passes into the undercooled or metastable region, as shown by the dotted line.

The results for the freezing-points at several pressures are shown in figure 2 and in table 2, which also gives the change of volume $V - V'$ in cm^3. per gram. From these results it may

[6] A corresponding superheating of the solid has been observed only in rare instances.

be seen that the compressibility measurements of table 1 were extended by about 500 megabars into the region of undercooled liquid. At ordinary pressures the melting point of the sample used is 13.9°, but although it was a carefully purified and colorless preparation, a slight variation in pressure during melting was observed. This indicates a small amount of impurity remaining in the material and doubtless the melting point of pure dichloroethylsulfide at $P = 1$ is a few tenths of a degree higher than the figure here given.

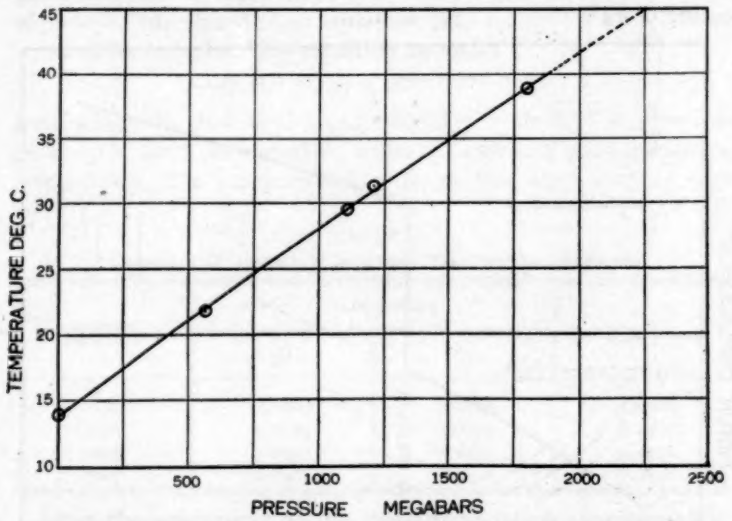

Fig. 2. The small circles in this figure represent the freezing points at various pressures. The smooth curve drawn through the circles is slightly concave toward the pressure axis.

In order to test for the possible existence of other solid modifications of this substance, the pressure on it was increased to 12,000 megabars at 38°; but no new forms were discovered.

From the data contained in table 2 we may calculate by the Clausius-Clapeyron equation the latent heat of melting. Thus

$$\Delta H = 0.02391 T(V_l - V_s)\mathrm{d}P/\mathrm{d}T,$$

where ΔH is the latent heat in calories per gram, T is the absolute temperature, $V_l - V_s$ is the change of volume on melting in

$cm^3./g.$, and dP/dT is the slope of the $P-T$ curve expressed in megabars per degree; practically it is the pressure in megabars required to raise the melting point one degree. Over the range of temperature covered by our measurements we find

$$\Delta H = 25 \text{ cal. per gram.}$$

This is a value which is higher than the latent heat of melting

TABLE 2

RESULTS FOR FREEZING PRESSURES, AND CHANGE OF VOLUME OF FREEZING

TEMP. °C.	FREEZING PRESSURE MEGABARS	$V_l - V_s$ $CM^3./G.$	dP/dT MEGABARS/DEG.	ΔH CALC.
13.9	1	(0.054)[a]	68	—
21.9	570	0.050	71	25
29.6	1110	...	—	—
31.4	1210	0.047	74	25
38.9	1800	0.042	77	25

[a] By extrapolation.

of most substances. On the other hand the compressibility and change of volume upon freezing do not differ markedly from the average for organic liquids.

BOTANY.—*A peculiar species of Lasiacis.* A. S. HITCHCOCK, Bureau of Plant Industry.

In 1759 Linnaeus described *Panicum divaricatum*[1] from Jamaica, distinguishing the species as divaricately much-branched. This is the first species to be described of a group having perennial branched, woody clambering or trailing stems, broad, flat blades, and panicles of smooth, roundish spikelets, set obliquely on the pedicels, the indurate fruit with a woolly tip. The aspect of the plants is that of a shrubby climbing bamboo. Several allied species have been described and referred to the genus Panicum. In 1864 Grisebach[2] recognized the group as a

[1] Syst. Nat. ed. 10. 2: 871. 1759.
[2] Fl. Brit. W. Ind. 551. 1864.

section of Panicum and gave to it the name Lasiacis, meaning woolly tip. The aspect of the species is so distinct and the technical spikelet characters so pronounced that the present writer elevated this section to the rank of a genus in 1910.[3] Lasiacis includes 13 species ranging from Mexico and the West Indies to Paraguay, one species entering the United States in semitropical Florida.

Lasiacis ruscifolia (H. B. K.) Hitchc. & Chase (*Panicum compactum* Swartz), is more variable and has a wider range than the other species. In an account of the genus as represented in the West Indies[4] occurs the following note:

"In all the Trinidad specimens the spikelets contain a second sterile lemma, a character not found in any other species known to us. This second sterile lemma equals the first, contains a hyaline palea, and infolds the fruit rather more closely than the sterile lemma commonly does in other species. The fruit borne one joint higher on the rachilla consequently faces in the direction opposite to the one in Paniceae, that is, the palea side of the fruit faces the second instead of the first glume."

A reconsideration of the group leads me to the conclusion that we have here a distinct species, for not only is there this unusual character of a second sterile lemma but also a distinct geographical range. Of the group to which it had been referred, all the specimens from Trinidad, the lower Orinoco, and eastern Brazil have a second sterile lemma, while outside of this range, that is, north and west, there is but one sterile lemma in all the specimens examined. In other respects, such as shape of blades and panicle, pubescence, shape and size of spikelets, the new species does not differ from *L. ruscifolia* from which it has been separated. The specimens of the new species, *Lasiacis anomala*, agree closely among themselves in all these characters, but also agree with many specimens referred to the more variable species *L. ruscifolia*.

The peculiarity of the case under consideration consists in the nature of the single diagnostic technical character, the second

[3] Contr. U. S. Nat. Herb. 15: 16. 1910.

[4] Hitchcock and Chase. *Grasses of the West Indies*. Contr. U. S. Nat. Herb. 18: 339. 1917.

sterile lemma. To those unfamiliar with the morphology of the grass spikelet it may be explained that the spikelets of the tribe Paniceae are characterized by two membranaceous bracts (glumes) at the base or outside, a third bract (sterile lemma) like the glumes in texture, and often enclosing a staminate flower but producing no seed, and finally a fertile lemma, which is indurate or at least thicker than the glumes, and which incloses a seed. The presence of a second sterile lemma is contrary to our concept of the whole tribe and if found here and there among our specimens would be looked upon as a teratological development. *A priori* one would be inclined to assign generic rank to a species or group of species possessing this character. In the case before us, however, the specimens possessing this character are indistinguishable in other respects from *L. ruscifolia*. Even specific rank is granted only because of the distinct range and the uniformity of the specimens. A technical diagnosis follows:

Lasiacis anomala Hitchc. n. sp.

Stems woody, branching, clambering over bushes, glabrous, the main culm as much as 5.5 mm. thick, and 5 meters long; sheaths glabrous or more or less pilose, striate, ciliate on the margin, densely villous on the collar; ligule a short ciliate membrane; blades ovate-lanceolate or elliptic lanceolate, as much as 10 cm. long and 3 cm. wide on the main flowering culms, usually 4–6 cm. long and 1–2 cm. wide on the lateral flowering branches, rather thin, narrowed and usually asymmetric at base, sometimes a little cordate-clasping, puberulent, or sometimes glabrate on the upper surface; panicles oblong-ovoid, 7–10 cm. long, 3–5 cm. wide, those on the lateral branches smaller, the lower branches somewhat distant, spreading or somewhat reflexed, all rather compactly flowered, puberulent, the pedicels angled, rather stout, 1–2 mm. long; spikelets ovoid, becoming nearly globose at maturity, 3–4 mm. long; first glume about one-third, second glume about two-thirds, as long as the spikelet; first and second sterile lemma about equal and about as long as the fertile lemma, the glumes and lemmas slightly woolly at the tip, the second sterile lemma infolding the fruit more closely than usual for the first lemma in other species; fruit ovoid-globose, obtuse, because of the presence of a second sterile lemma the palea side facing the second glume.

Type in the U. S. National Herbarium, no. 865557, collected along the edge of jungle, Fort George Road, Port of Spain, Trinidad, November 27, 1912, by A. S. Hitchcock (Amer. Gr. Nat. Herb. no. 595).

DISTRIBUTION: Trinidad to eastern Brazil.
SPECIMENS EXAMINED.
TRINIDAD: *Broadway* 2504, 2564, 2627; *Bot. Gard. Herb.* 2303; *Hitchcock* 10001, 10063, 10117, 10136.
VENEZUELA: Santa Catalina, *Rusby & Squires* 358; Island of Margarita, *Miller & Johnston* 184.
BRAZIL: Rio Branco, *Kuhlmann* 3358; Ceara, *Gardner*, 1889, 1894.

TECHNOLOGY.—*The determinateness of the hysteresis of indicating instruments.* F. J. SCHLINK, Bureau of Standards.

STATEMENT OF THE PROBLEM

The purpose of the present paper is to set down briefly the results of one of several concordant preliminary experiments carried out to determine to what extent hysteresis or variance determinations with respect to nonintegrating mechanical measuring instruments are themselves sufficiently definite and reproducible to warrant wide application in instrument testing, calibration, and utilization. The conclusion is reached that no extraordinary experimental care is required to arrive at hysteresis determinations of very definite utility, and that, under stated conditions, such determinations are of a highly reproducible character. These results are forecast in a paper just completed by the author, to which the reader may refer for a general discussion of hysteretic cycles in the operation of measuring instruments and of the fundamental relation which such cycles bear to testing and calibration.[1]

APPARATUS AND METHOD

In order to minimize the experimental difficulties and to permit of useful generalization of the results of the investigation, the instrument chosen as the basis for this work was a spring-controlled self-indicating weighing scale of the stabilized-platform pointer-and-dial type, a sort commonly used for the weighing of postal and express parcels, and to a very limited extent of vegetables and other low-priced commodities of trade. The choice of this particular type of instrument, shown dia-

[1] *The concept of resilience with respect to indicating instruments.* To be published in the Journ. Franklin Inst., February, 1919.

grammatically in figure 1, was influenced by the following major considerations:

1. It comprises many elements typical of measuring instruments generally, including: (*a*) a helical force-resisting spring; (*b*) a link work of several jointed bars; (*c*) a rack and pinion for magnifying the motion of the parts and transmitting it to a pointer rotating over a full circle of graduations; (*d*) a large

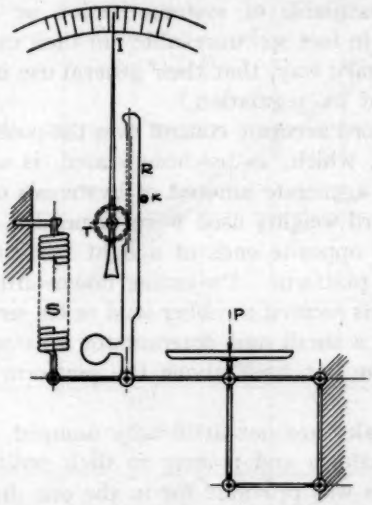

Fig. 1. Schematic illustration of mechanism of stabilized-platform pointer-and-dial type of spring scale. It will be noted that an eccentric disposition of the load on the platform is associated with a horizontal reaction in the check-rod (the lowermost link shown). The friction of the terminal journal bearings of this rod is proportional to this reaction, and hence to the product of the load itself and the displacement of its center of gravity from the center of the platform.

mechanical backlash (0.20 to 0.28 radian—11° to 16°—at the pointer) which is only partially compensated by gravitational force-closure.

2. The independent variable, *viz*, the load weighed, is essentially nonhysteretic and, therefore, admittedly reproducible with very high precision.

3. The aggregate fractional resistances of the apparatus are inherently large and moreover subject to ready control

within a wide range by simply varying the point of application of the load upon the platform in a direction parallel to the plan of the platform-supporting linkwork.[2]

4. As a consequence of the large frictional resistances, the variance of the indications of such a scale is so great as to be very easily observed and has, in common with that of many other crude and ill-constructed instruments, hitherto been deemed quite incapable of systematization or regularization. (Such scales are in fact so "unreliable" in their indications when read in the ordinary way, that their general use in trade is commonly prohibited by regulation.)

In order to afford accurate control over the position of application of the load, which, as has been stated, is a factor largely determining the aggregate amount of hysteresis of scales of this type, the standard weights used were suspended from below by cords secured at opposite ends of a light horizontal bar superimposed on the platform. Projecting downward from the center of this bar was secured a rubber stud or tip serving to localize the load within a small and determinate area on the platform while holding the bar itself above the platform and free from contact with it.

Since such scales are not artificially damped, gradual movement of the platform and pointer to their positions of rest at the several loads was provided for in the one direction by gentle and careful application of the weights manually, and in the other by the use of the relatively slow motion of the rack-and-pinion gear of a microscope stand by which a vertical rod was gradually withdrawn from contact with the upper surface of the platform after the removal of a given weight increment. By these means it was possible to assure aperiodic, reasonably steady, and shockless motion of the pointer, without overshooting of the rest point. The reasons and basis for this method are discussed in detail in the first reference cited. Regularization of operation of the scale, or the setting up of the cyclic state, treated in the same reference, was carried out before beginning the experiment by simply operating the scale a number of times

[2] See Bureau of Standards Technologic Paper No. 106.

over the actual maximum range of movement involved in the weighing of the capacity load.[3] Limitations of space prohibit

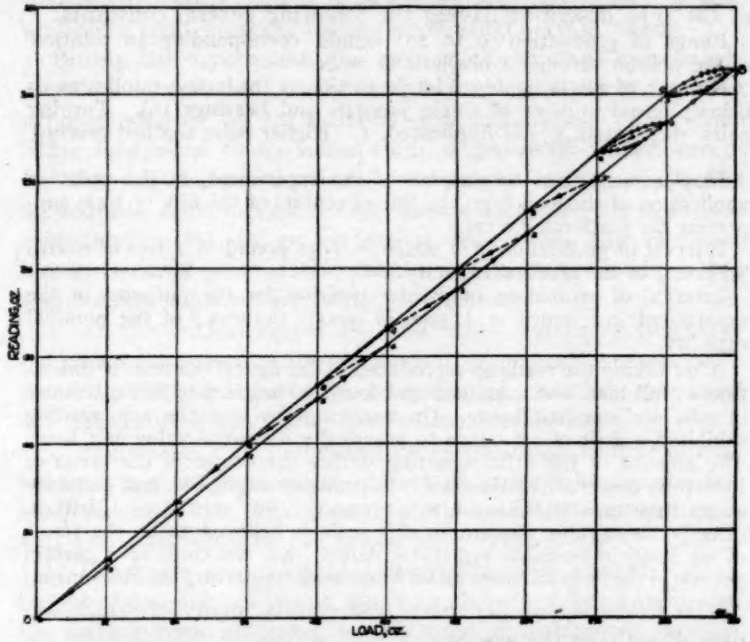

Fig. 2. Results of cyclic calibrations of stabilized-platform pointer-and-dial type of spring scale. Dotted lines connect points in a series of observations in which the detail path of the function was not then determined. The numbers to the right of the determinations indicate the number of the check observations taken, which gave substantially (see text) the same value as the observation recorded.

detailed consideration of these prerequisites in the present necessarily brief discussion.

[3] It was important to determine whether cyclic states set up on different occasions were actually identical, and to this end, the scale was strongly jarred and disturbed between successive runs, so as to insure definite dislocation of the acquired relations of journals and bearings, gearing, etc., within the limits, of course, of the clearances obtaining. Renewed cyclic operation of the scale brought about a regularization as perfect as could be desired, a result hardly less than astonishing, when the essential crudity of the instrument is considered. The finish and fit of the moving parts of this type of scale are of a sort that would be considered intolerable in any ordinary engineering instrument, *e. g.*, a Bourdon gage or a pocket voltmeter.

THE PARTICULAR RESULTS OBTAINED

Figure 2 presents the results of the cyclic calibration of a scale of the type described having the following general constants:

Range of graduation: 0 to 20 pounds, corresponding to rotation of the pointer through 2 revolutions = 4π.

Number of joints having relative motion, 7 (including duplicates as below; actual number of single journals and bearings 10). Turning pairs: duplicated, 5; not duplicated, 1. Higher pairs toothed gearing, 1.

Displacement, for the purpose of the experiment, of the point of application of the load from the line of centers of the link or stem supporting the platform, 7.0 cm.

Interval of graduation: 1/2 ounce = 1/32 pound = 1/640 or 0.0016 (approx.) of the nominal capacity.

Interval of estimation of pointer position for the purposes of the experiment: 0.1 ounce = 1/3200 or 0.0003 (approx.) of the nominal capacity.

After taking the readings reproduced in the figure, the drift of indication at full load was examined and found to amount to but 0.5 ounce in nine and one-half hours. On removing the load the zero reading exhibited a drift of 1.2 ounce to practically its initial value in 1 hour. The amount of the drift occurring during the course of the series of hysteresis observations recorded was probably negligible, and certainly at no time greater than 0.1 to 0.2 ounce. The existence of drift in directly measurable amount in this scale is believed to be the result of an easily remediable structural defect, *viz*, weakness of a certain portion of the inelastic sheet metal framework supporting the mechanism.

The following are the particular results, many of which appear directly in the graph:

1. The hysteresis loop,[4] or any portion of it, except at such a critical region as that designated *BC* in the figure, determined under the condition of slow aperiodic change of reading, was practically reproducible within a maximum deviation of one- to two-tenths of a graduation or at the largest separation of the loop where the relative precision is high, within a precision of about one or two parts in one hundred. It is to be noted that this small amount of dispersion of readings corresponds to a mutual displacement of repeated readings of but one-half the

[4] It is to be noted that the hysteresis obtained is for the major part the result of frictional resistances and, concomitantly, of bearing clearances. (See Bureau of Standards Scientific Paper No. 328.) It is known that only a relatively very small portion of the hysteresis observed can be the result of elastic hysteresis of the resisting spring of the scale.

width of the lines of the diagram. It is believed that a reproduction of the cycles even more precise would have resulted, had more delicate means of releasing the load upon the pan, and more rigid supports for the apparatus, been at hand.

During the experiment, the zero point remained surprisingly constant except that at the completion of the second run, it dropped sharply by three-tenths of a graduation, after which being readjusted to its initial value it remained stable except for the drift before mentioned, throughout a great number of subsequent observations. This displacement of the zero was undoubtedly due to an accidental irreversible slip of some loosely secured part of the exterior frame of the scale, which was notably deficient in rigidity, or of the dial.

2. At the critical region *BC* and other regions of beginning backward movement of the mechanism, the existence of a marked passivity due to imperfectly compensated backlash, increased the dispersion of successive observations considerably.

3. The curves corresponding to reversal of the change of load before the extreme range of indication under investigation has been reached, are rapidly asymptotic severally to the upper and lower branches of the major loop, respectively.

4. The major loop tends to a decidedly skew lenticular form, roughly triangular, a result which is the direct consequence of the force system obtaining in this type of instrument, in that the frictional resistances tend to increase proportionally to the load, when the reactions in the stabilizing check are large. Other indicating instruments are more likely to give a loop of nearly symmetrically lenticular form.

GENERAL CONCLUSIONS

The general conclusions educible in the main from the present data, though fully supported collaterally by a considerable mass of experimental data necessarily omitted here, and by analogy, are the following:

1. The hysteresis loops obtained in the specified cyclic calibration of a (nonintegrating) mechanical measuring instrument nearly free from transient after-effects at rates of operation ob-

taining in the experiment, are highly reproducible and invariant in themselves, *even in the presence of very considerable instrumental friction* and the resulting so-called unreliability of indication.

2. If the instrument is used therefore under the conditions hereinbefore specified as defining the manner of its calibration, the positiveness and certitude of its indications over a very large portion of its range of indication are enormously increased, as compared with the results of operation in the ordinary and unregularized manner.

3. The middle portion of the calibration loop while in general exhibiting the largest absolute range of variability or variance of indication, in the ordinary manner of operation of the instrument, is the region most useful for obtaining results of the highest relative precision in the cyclic manner of operation above outlined.

4. Knowing the operational history of the instrument subsequent to regularization,[5] accurate reduction of a given indication can be carried out by this method with complete elimination of first-order variance.

5. The limiting values of the variant (casual or nonrepetitive) errors of such an instrument can be accurately set down upon the performance of a calibration of the type referred to, for any given range of operation in question, since the major loop corresponding to that range circumscribes and completely encloses

[5] In this connection it is clear that one of the factors tending to make the history of the instrument movement uncertain can be eliminated by application of critical or over-critical damping, since the effect of this expedient is to obviate the more or less irregular and indeterminate oscillations of the indicator about its rest point, which would normally depend upon the rate and manner of change of the independent variable during its application. The utility of such damping is especially marked, for instance, in the case of the controlled use in the laboratory, of automatic weighing scales which commonly revert to zero between weighings, since in such cases, the damping assures approach to the rest point over an accurately determinate functional path. In this connection it should be mentioned that critical or over-critical damping will be definitely disadvantageous if regular reversion of the instrument to its zero cannot be depended upon. Moreover, if the scale in question is to be used without correction of its readings, its adjustment to critical or over-critical damping implies that the calibration of the dial shall have been performed with respect to the curve of increasing readings, while the application of simple additive corrections, if they are to be used, is to be carried out with reference to the same branch of the hysteresis loop.

all minor or secondary loops observed over ranges of indication between its own terminal limits.

6. When the result of (4) is impracticable or inconvenient on account of the uncontrolled nature of the service to which the instrument is subjected, the best average result in the use of an instrument will in general be obtained when its scale values are adjusted to the mean[6] of the upper and lower limits of the maximum hysteresis loop rather than to the lower branch thereof, since when the cyclic history is unknown or indeterminate, indications within the loop are indefinitely more probable of occurrence than indications on its periphery.

[6] The mean is a first approximation to the position of the "normal" calibration line, in the absence of specific information regarding the skewness of the chance distribution of indications *across* the loop.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The general character of specific heats at high temperatures.* WALTER P. WHITE. Proc. Nat. Acad. Sci. **4**: 343–346. November, 1918.

The specific heats of three forms of silica and two silicates (alkali feldspars), determined for temperatures up to 1300°, indicate that the atomic heats at constant volume for the substances increase above the theoretical value 5.96, as the heats of metals have been known to do, and hence that such increase is a very general phenomenon, as has been suspected. W. P. W.

PHYSICS.—*Calorimetric lag.* WALTER P. WHITE. Journ. Amer. Chem. Soc. **40**: 1858–1872. December, 1918.

The lag effects of bodies external to calorimeters, although more complicated in expression, are found to follow the same general laws as the simpler lag effects already described. More carefully stated than previously, these effects prove to be three: (1) equivalent to the heat capacity of the calorimeter; this can be eliminated if a calorimeter is directly calibrated; (2) much smaller, depending on the amount of thermal leakage; this can be avoided, if necessary, by using the adiabatic method; (3) dependent on the jacket temperature, which disappears for constant jacket temperature; this one causes the calorimeter to have a different effective heat capacity when used adiabatically. W. P. W.

INORGANIC CHEMISTRY.—*The ternary system MgO–Al_2O_3–SiO_2.* G. A. RANKIN and H. E. MERWIN. Amer. Journ. Sci. **45**: 301–325. April, 1918.

The temperature-concentration relations of the various crystalline phases in equilibrium with liquid in the ternary system MgO–Al_2O_3–SiO_2 have been investigated, and are represented by diagrams and a model. A ternary compound, $2MgO.2Al_2O_3.5SiO_2$, unstable at its

melting point and considerably affected by solid solution has been observed in two forms. The μ-form (unstable) crystallizes from glass at temperatures below about 950°, and transforms at somewhat higher temperatures into the α-form (stable). The properties of both forms, but especially the α-forms, are close to those of the mineral cordierite. The effects of solid solution in flattening two of the boundary curves of the field of this compound are discussed. The preparation and properties of crystalline aggregates of substances which dissociate when melting are considered. Crystals of natural cordierite dissociate when melting. Brief consideration is given to the effects of FeO in magnesian rocks and minerals. H. E. M.

INORGANIC CHEMISTRY.—*Solubility and fusion relations at high temperatures and pressures.* GEORGE W. MOREY. Journ. Engin. Club Phila. **35**: 509–519. November, 1918.

An address, giving a popular discussion of the principles underlying the solubility relations of binary systems composed of both volatile and nonvolatile components. In addition, some new compounds of the alkalies with Al_2O_3 and Fe_2O_3 are described, as well as a new method for determining solubilities under difficult experimental conditions. G. W. M.

PHYSICAL CHEMISTRY.—*The laws of chemical equilibrium.* ERSKINE D. WILLIAMSON and GEORGE W. MOREY. Journ. Amer. Chem. Soc. **40**: 49–59. January, 1918.

In examining the complicated chemical systems which present themselves in the study of geophysical problems it is found that the approximate formulas used for dilute solutions break down and prove worse than useless even for qualitative application. The monumental work which the genius of Willard Gibbs evolved in 1876 remains the safest guide and that to which reference must necessarily be made. The extreme mathematical setting with which he surrounds his arguments has militated against the general use of his results by chemists, and a consequence of this is that much ink has been spilled in proving by roundabout and far from rigid methods, theorems which are either explicitly stated by Gibbs or are so readily deducible from his equations as to be implicit in his work. This paper has therefore been written as an attempt to popularize, in so far as such a term can be used in this connection, the derivation of the fundamental equations and to deduce from them such additional formulas as are found neces-

sary for the derivation of the theorems bearing on the chemical side of equilibrium. The applications of these theorems to actual cases will be discussed in later papers. R. B. S.

PHYSICAL CHEMISTRY.—*Pressure-temperature curves in monovariant systems.* GEORGE W. MOREY and ERSKINE D. WILLIAMSON. Journ. Amer. Chem. Soc. 40: 59–84. January, 1918.

Willard Gibbs, in his paper "On the equilibrium of heterogeneous substances," derives expression giving the relation between the variations in pressure and temperature in monovariant systems. The authors derive from this equation two fundamental theorems concerning the relations of the $P-T$ curves in such a system, for the case where a linear relation exists between the compositions of r or fewer phases in a system of r components. These considerations make possible (with no other knowledge than the composition of the phases at an invariant point) the fixing of the order of succession of the $(n+2)$ $P-T$ curves which proceed from an invariant point in a system of n components and (when the state of aggregation of the phases is known in addition) the fixing of their actual position within fairly narrow limits. This is illustrated by considering the $P-T$ curves which proceed from the five quintuple points in the ternary system H_2O–K_2SiO_3–SiO_2. Gibbs' general equation is not in a form which is convenient to apply. A general method is given for casting it into a convenient form for practical use and a concrete interpretation of the coefficients involved is given. The application of this equation to the actual slope of the $P-T$ curves, and especially to the change in slope with change in composition of phases of variable composition, is discussed in detail, taking as examples typical $P-T$ curves from the ternary system H_2O–K_2SiO_3–SiO_2. R. B. SOSMAN.

GEOLOGY.—*Some manganese deposits in Madison County, Montana.* J. T. PARDEE. U. S. Geol. Survey Bull. 690-F. Pp. 131–143. 1918.

The deposits are along the west side of Madison Valley near Cherry and Wigwam creeks and in the foothills east of Jefferson Valley, near Renova, localities that are, respectively, 70 and 30 miles southeast of Butte, Mont. Though the deposits are small, they yield ore that is almost free of silica and is therefore very desirable for making ferroalloys. They are also of interest because the manganese in them is

primarily of sedimentary origin, and accordingly they differ from most of the other manganese deposits known in this general region, which are related to metalliferous quartz veins.

On Wigwam and Cherry creeks irregular lenslike bodies of manganese oxides, chiefly psilomelane and subordinately manganite and wad, are found in an ancient marbleized limestone that underlies the Cambrian Flathead quartzite. The general features of these deposits clearly show that the ores were deposited in solution cavities and have also made room for themselves by replacing the limestone. Their composition and structure suggest that they were deposited by surface waters circulating through joints or other openings in the limestone, probably during the Tertiary period. Under these conditions the only apparent source of the manganese is the limestone itself, which contains small proportions of manganese and iron oxides.

Iron ore and manganiferous iron ore are exposed about 3 miles southwest of Renova. The localization of the deposits at the top of shales overlying the Flathead quartzite and their close association with an old surface of erosion suggest that they are portions of an iron-bearing stratum enriched by weathering when the land was being worn down to the level of the old surface and therefore are to be regarded as primarily of sedimentary origin. If this is the true explanation, similar ore bodies are to be expected at the same geologic horizons in the neighboring districts. R. W. STONE.

GEOLOGY.—*The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska.* THEODORE CHAPIN. U. S. Geol. Survey Prof. Paper 120–D. Pp. 83–100. 1918.

The discovery of fossils of Jurassic or Cretaceous age has made possible some changes in the geologic mapping of Gravina Island. This paper is a supplemental report on the region and discusses the distribution, character, structure, stratigraphic relations, age, and correlation of rocks ranging from Devonian to Quaternary. R. W. STONE.

GEOLOGY.—*The Nesson anticline, Williams County, North Dakota.* A. J. COLLIER. U. S. Geol. Survey Bull. 691–G. Pp. 211–221, with map and section. 1918.

The Nesson anticline, discovered by a U. S. Geological Survey party in 1917, is a fairly well marked arch or dome about 30 miles east of

Williston. It is of interest because the rocks of North Dakota in general lie nearly flat, and because an artesian well drilled a few miles west of the crest of the anticline yields a small flow of gas. The stratigraphy and structure are described, and it is suggested that wells be drilled nearer the crest of the anticline in search of a larger flow of gas.

R. W. STONE.

GEOLOGY.—*Geology and oil and gas prospects of the Lake Basin field, Montana.* E. T. HANCOCK. U. S. Geol. Survey Bull. 691–D. Pp. 101–147, with maps, sections, and illustrations. 1918.

Describes the Cretaceous and Tertiary stratigraphy of an area northwest of Billings, discusses the structural folds and numerous faults in detail, and recommends that drilling be done in the Big Coulee-Hailstone dome in a search for oil and gas. If that dome proves barren, the possibility that oil and gas occur in commercial quantities in the Lake Basin is believed to be very slight. R. W. STONE.

MAMMALOGY.—*East African mammals in the United States National Museum. Part. I. Insectivora, Chiroptera, and Carnivora.* N. HOLLISTER. Bulletin 99, United States National Museum. Pages 1–194; 3 text figures; plates 1–55. August 16, 1918.

This first volume of a bulletin dealing with the extensive collection of East African mammals preserved in the National Museum, to be completed in three parts, consists of a general introduction, brief historical account of the collection, a map with a dictionary of localities and annotated lists of specimens of the insectivores, bats, and carnivores. The collections made by the Smithsonian African expedition under the direction of Col. Theodore Roosevelt, 1909–10, and by the Paul J. Rainey expedition, 1911–12, form the basis of the work, but all specimens from Sudan, Eritrea, Abyssinia, Somaliland, Lado Enclave, Uganda, British East Africa, German East Africa, and Zanzibar, received by the Museum from any source, are listed. These collections contain 1,833 specimens of mammals of the three orders, representing 155 species. There are 64 types. Generic and specific synonymies; type localities and location of type specimens; lists of specimens with critical notes; tables of external, cranial, and dental measurements; and field notes recorded by the collectors are given. The plates illustrate the skulls of all type specimens. N. H.

ORNITHOLOGY.—*Food habits of the swallows, a family of valuable native birds.* F. E. L. BEAL. U. S. Dept. Agr. Bull. **619**: 1–28; pls. 1–2. 1918.

So far as agriculture is concerned, there is no more useful family of birds than the swallows. Of the thirteen species of this group occurring in the United States, seven are so widely distributed that their food habits are of much economic importance. These are *Progne subis*, *Petrochelidon lunifrons*, *Hirundo rustica erythrogastris*, *Iridoprocne bicolor*, *Tachycineta thalsassina*, *Riparia riparia*, and *Stelgidopteryx serripennis*. The study of the food of these species shows that they are, like the rest of the swallows, practically not at all harmful to man, since they injure neither wild nor cultivated fruit or seeds, nor molest other birds. With the exception of one species, *Iridoprocne bicolor*, all the United States swallows are almost exclusively insectivorous, yet they do not disturb domestic bees or silkworms or devour unusual numbers of other beneficial insects. On the other hand, they feed on some of agriculture's worst insect pests, among them the cotton-boll weevil, clover weevil, alfalfa weevil, and chinch bug.

Since swallows feed almost entirely while on the wing, it follows that most of the insects they catch are flying species. Hymenoptera, Diptera, Hemiptera, and Coleoptera, form about eighty-five per cent of the food of the swallows in the United States. Orthoptera, a favorite item of food with many birds, and Lepidoptera are not eaten to any considerable extent. Among the food elements of each of the United States species examined there were found a great number of different species of insects, and lists of such discovered during the course of stomach examinations are given; that under *Petrochelidon lunifrons* amounts to 149. The only North American swallow that subsists to any extent on vegetable matter is *Iridoprocne bicolor*; in the case of this species to the extent of twenty per cent. Most of the vegetable fruit of this bird is made up of the berries of the bayberry; the rest of such wild berries as those of the red cedar and Viriginia creeper.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on North American birds. V.* HARRY C. OBERHOLSER. The Auk **35**: 185–187. 1918.

The North American goshawk, *Accipiter atricapillus* Wilson, appears to be a subspecies of the European goshawk, and its two present subspecies should, therefore, stand as *Astur gentilis atricapillus* (Wilson); and *Astur gentilis striatulus* Ridgway. The American golden-crowned kinglets are evidently subspecies of the European bird, and their names

should thus become *Regulus regulus satrapa* Lichtenstein, and *Regulus regulus olivaceus* Baird. The form of fox sparrow called by Riley *passerella iliaca altivagans* has been discredited by most recent authors, but is shown by further study to be a recognizable race. The same is true of *Melospiza melodia inexspectata* Riley from Moose Lake, British Columbia. H. C. O.

ORNITHOLOGY.—*The crow and its relation to man.* E. R. KALMBACH. U. S. Dept. Agr. Bull. 621, 1–92; pls. 1–2; figs. 1–3. 1918.

This bulletin concerns only the races of the common crow, *Corvus brachyrhynchos*, with its various subspecies. These together inhabit practically all the United States and Canada. In the eastern United States the species is common and ranges over all kinds of country. It is one of the species that gather into roosts, particularly during the winter season, and at such times as many as nearly 300,000 birds sometimes assemble. Its close association with man makes its economic relations of much importance, and owing to its practically omnivorous habits the study of its habits presents more complicated problems than that of almost any other North American bird. In fact, not less than 656 specifically different items have been identified in stomach examinations. The present investigation is based on 2118 stomachs and some 3000 circulars of inquiry. The results show that the chief food of the crow consists of corn and insects; the latter chiefly Coleoptera, Orthoptera, Lepidoptera (larvae), and Hemiptera. Some spiders and crustaceans are also taken, as well as reptiles and amphibians, together with small mammals, principally rodents. One of the crow's most injurious habits is the destruction of wild birds and their eggs, and young poultry; but the latter can be partly if not wholly prevented by proper care. In some places, particularly in the southern United States, the crow often resorts to carrion for food, and under similar circumstances molests livestock.

The conclusion regarding the economic status of *Corvus brachyrhynchos* reached through the present investigation is that when feeding on injurious insects, crustaceans, rodents, and carrion it is beneficial; but when destroying small reptiles, amphibians, wild birds, poultry, corn and other crops, and disturbing livestock, it is injurious. Any necessary means should be employed to prevent its depredations, but the species is at times too beneficial to be entirely exterminated. It has practically no natural enemies, and a reasonable reduction of numbers by man in areas where there are too many crows is desirable.

HARRY C. OBERHOLSER.

VITAL STATISTICS.—*The relation between birth rate and death rate in a normal population and the rational basis of an empirical formula for the mean length of life given by William Farr.* ALFRED J. LOTKA. Quart. Publ. Amer. Statist. Assoc. **16**: 121. 1918.

In a previous publication it was shown by the author that under constant conditions the relation between birth rate per head b and death rate per head d in an isolated population approaches the form

$$1/b = \int_0^\infty e^{-(b-d)a} p(a)\, da \qquad (1)$$

where $p(a)$ is the probability, at birth, that a random individual will reach age a.

When the relation (1) is plotted in rectangular coordinates it bears an outward resemblance to a hyperbola.

We may write (1) in the parametric form:

$$b = 1/L + mr + nr^2 + \ldots \qquad (2)$$

$$d = 1/L + (1-m)r + nr^2 + \ldots \qquad (3)$$

where r is the natural rate of increase of the population and L is the mean length of life (expectation of life at birth).

Neglecting the second and higher powers of r it is easily shown that (2) and (3) are equivalent to the relation (4) between b and d,

$$\left(b - \frac{1-m}{L}\right)\left(d - \frac{m}{L}\right) = \frac{m(1-m)}{L^2} \ldots \qquad (4)$$

which, it will be seen, is indeed hyperbolic in form.

On the other hand, Equation 4, when expressed as a relation between $1/b$ and $1/d$ assumes the simple linear form

$$\frac{1-m}{b} + \frac{m}{d} = L \qquad (5)$$

a relation which is identical in form with Farr's empirical formula for the mean length of life

$$\frac{1}{3}\cdot\frac{1}{b} \times \frac{2}{3}\cdot\frac{1}{d} = L \qquad (6)$$

The empirical cofficients $1/3$ and $2/3$ which occur in Farr's formula thus receive a rational interpretation.

Numerical illustrations taken from British Statistics are given in the original. A. J. L.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on November 25, 1918. Progress was reported on arrangements for a meeting place for the affiliated societies and the problem offered by the rapidly increasing cost of publication of the JOURNAL was considered.

The Board of Managers met on December 13, 1918. The Editors were authorized to transfer the contract for printing the JOURNAL for 1919 from the Williams & Wilkins Company, of Baltimore, to the Eschenbach Printing Company, of Easton, Pennsylvania.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL: Rear Admiral GEORGE WASHINGTON BAIRD, U. S. N., Retired, 1505 Rhode Island Avenue, Washington, D. C.; Dr. ATHERTON SEIDELL, Hygienic Laboratory, Public Health Service, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 587th regular meeting of the Society was held in the Assembly Hall of the Carnegie Institution, Saturday, November 30, 1918; called to order at 8.10 p.m. by Vice President HOPKINS; 35 persons present.

Deaths of the following members were noted: DOUGLAS C. MABBOTT, killed in France; D. E. LANTZ, former Recording Secretary of the Society, victim of the recent epidemic of influenza; and FREDERICK KNAB.

Informal communications were presented as follows:

Dr. L. O. HOWARD called attention to a communication and specimens he had received from Charles Russell Orcutt, of California. The specimens had been identified by Dr. Paul Bartsch as a noxious European snail and had been discovered by Mr. Orcutt in a restricted area in California. Dr. Howard told of the steps that were being taken by the state to exterminate this newly imported species. This communication was commented upon by Dr. Bartsch, who mentioned other introduced species of snails which had become pests.

Dr. T. S. PALMER brought to the attention of the Society that the year 1918 had been a very prosperous one for the A. O. U. in spite of wartime conditions. There are 950 members of the A. O. U., of whom 75 are in France. Of the latter, DOUGLAS C. MABBOTT, also a member

of the Biological Society, had been killed. Doctor Palmer called attention to the several species of birds of paradise now on exhibit by the New York Zoological Society. He also referred to the increased cost of food seeds for caged birds incident to the war. The question of food seed shortage and substitute was discussed by Mr. W. L. McATEE.

Major R. W. SHUFELDT spoke of various preserving fluids for anatomical, pathological, and zoological specimens. He exhibited several specimens preserved by them, and called attention to some of their advantages.

The regular program was as follows:

A. S. HITCHCOCK: *Some notes on the botany of Long's Peak, Colorado.* It was illustrated by numerous lantern slides.

M. W. LYON, JR.: *Influenza.* A brief account of the symptomatology and etiology of the recent epidemic of influenza.

The paper was discussed by Dr. H. S. BENNETT, L. O. HOWARD, R. W. SHUFELDT, W. P TAYLOR, and others.

The 588th regular and 39th annual meeting of the Society was held in the Assembly Hall of the Carnegie Institution Saturday, December 14, 1918; called to order at 8.00 p.m. by President ROSE; 18 members present.

On recommendation of the Council the following named persons were elected to membership: MAUNSELL S. CROSBY, W. LEE CHAMBERS. CHARLES B. CORY, CHARLES C. DEAM, GEORGE L. FORDYCE, C. I, CLAY, ALBERT O. GARRETT, MORTON J. ELROD, HENRY W. FOWLER, H. M. DENSLOW, H. GIFFORD, JOHN DRYDEN KUSER, V. A. HUARD, ARTHUR H. HELME, PHILIP DOWELL, EDWARD A. MCILHENNY, W. E. SAUNDERS, FRANK SMITH, ARETAS A. SAUNDERS, W. B. MERSHON, E. LAWRENCE PALMER, LYNDS JONES, ALTHEA R. SHERMAN, ROBERT THOMAS MOORE, FRANK L. BURNS, HARRY B. WEISS, FREDERIC C. KENNARD, CHARLES THEODORE RAMSDEN, CARL OTTO ROSENDAHL, SAMUEL F. RATHBUN, REGINALD CHARLES TREHERNE, ALEXANDER HOWARD MACKAY, RAYMOND J. POOL, P. A. TAVERNER, C. B. WILLIAMSON, JOSEPH MAILLIARD, JOSEPH FRANCIS CHARLES ROCK, J. CHESTER BRADLEY, JAMES ALEXANDER MUNRO, CHARLES W. HOWARD, FRANK S. DAGGETT, FRANK T. MCFARLAND, CHARLES A. SHULL.

Reports of Officers and committees for the year 1918 were received.

Election of officers for the year 1919 resulted as follows:

President, H. M. SMITH; *Vice Presidents*, A. D. HOPKINS, VERNON BAILEY, N. HOLLISTER, A. S. HITCHCOCK; *Recording Secretary*, M. W. LYON, JR.; *Corresponding Secretary*, W. L. MCATEE; *Treasurer*, N. DEARBORN; *Members of Council*, J. W. GIDLEY, WM. PALMER, E. A. GOLDMAN, ALEX. WETMORE, H. C. OBERHOLSER.

President SMITH was nominated for Vice President to represent the Society in the Washington Academy of Sciences.

M. W. LYON, JR., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

At the annual meeting of the Board of Regents of the Smithsonian Institution, held on December 12, 1918, Senator THOMAS, of Colorado, and Representatives FERRIS, PADGETT, and GREENE were elected to membership on the Board.

The Bureau of Fisheries, U. S. Department of Commerce, will build a new laboratory, estimated to cost $50,000, at Seventh and B Streets.

Experimental work at the American University Experiment Station, of the Chemical Warfare Service was discontinued on December 31, the most of the personnel having been transferred or discharged. A few of the officers remain to write up reports of the work of the Station.

Dr. N. L. BOWEN, of the Geophysical Laboratory, Carnegie Institution, has accepted the professorship of mineralogy at Queen's University, Kingston, Ontario.

Major General WILLIAM CROZIER, U. S. A., former Chief of Ordnance and later commander of the Northeastern Military Department at Boston, has been transferred to the retired list of the Army on his own application, after a service of nearly forty years.

Professor E. C. FRANKLIN returned to Stanford University, California, in December, after spending the greater part of the past year in research on the synthetic process for the fixation of nitrogen.

Dr. GEORGE E. HALE, of the National Research Council, and Prof. A. A. NOYES, of the Nitrate Committee, returned from England in December.

Mr. HENRY HINDS has resigned from the Geological Survey to enter the employ of the Sinclair Oil and Gas Company, at Tulsa, Oklahoma.

Lieut. HERBERT GRAHAM KUBEL, formerly cartographer with the U. S. Geological Survey, died on December 30, 1918. He left the position of acting chief engraver of the Survey in January, 1918, to receive a commission as first lieutenant in the Air Service. He was a member of the Society of Engineers.

Dr. H. A. LUBS has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to enter the employ of E. I. du Pont de Nemours & Company.

Prof. J. C. MERRIAM, of the National Research Council, returned to the University of California in December.

Professor JOJI SAKURAI, director of the newly established Institute of Physical and Chemical Research in Tokyo, Japan, visited Washington in December.